The mesostructural evolution of *Nannoconus* via ptychographic X-ray computed tomography

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Among the calcareous nannofossils present in the lower Cretaceous oceans, the *Nannoconus* group has the largest exoskeleton (5-30 µm) and was the main planktonic carbonate bioproducer. Knowledge of the organism that produced the 3D conical exoskeleton of *Nannoconus* is nonexistent, but a detailed analysis of both morphology and structure of the exoskeleton can give information about its mode of calcification and paleobiology. The exoskeleton presents a great variability of plate arrangements which has allowed the recognition of 9 morphogroups that appear successively during the nearly 35 million years of climax and could explain this success story. Furthermore, turnovers in abundance of the dominant morphogroups were observed, probably associated with environmental changes that may have caused their morphological evolution. The main question driving this study is: Has the morphology evolved significantly in adapting to the environment?

To better understand the exoskeleton construction and this variability, there is a need to correlate the *Nannoconus* microstructure at the nanometer length scale with their environment. To answer this question, we use the X-ray ptychographic computed tomography to determine the 3D structure of different *Nannoconus* from various ages at the nm level (resolution of a few tens of nm). The need for high spatial resolution tomography is supported by the small size of the inner structural elements, on the order of ~100 nm thick and a few µm long.

Sediment samples containing well-preserved *Nannoconus* have been selected from Hole-603B of the DSDP Leg 93 and Munk Marl formation of the North Sea that range from Valanginian (~140 Ma) to Aptian (~113 Ma) age. A filtration process has been applied to the sediment suspension powder in order to increase the abundance of *Nannoconus*. Because *Nannoconus* recrystallise easily, their state of preservation has been verified with both optical and scanning electronic microscopy. Raman microspectroscopy has been used to characterize the mineralogy, revealing very pure calcite crystals. Finally, more than ten best-preserved *Nannoconus* have been

isolated from the sedimentary matrix using the picking techniques we developed. Once isolated, various species of *Nannoconus* have been analyzed with ptychographic X-ray computed tomography (PXCT) at the experimental station of SWING at the SOLEIL French synchrotron (June 2022), evaluating morphological evolutions. Interpretation of the results obtained during this experiment is still in progress and will be presented during the meeting.